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**ARMED SERVICES VOCATIONAL APTITUDE BATTERY
(ASVAB) FORMS 20, 21, AND 22:
ITEM DEVELOPMENT**

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13. ABSTRACT (Maximum 200 words) The Armed Services Vocational Aptitude Battery (ASVAB) is a multiple aptitude test battery consisting of 10 subtests that is used by the military services to select and classify enlisted personnel. Periodic replacement of operational forms of the ASVAB is necessary to discourage compromise and to update content. This paper details the development and pilot administration of new items for the next round of operational ASVAB Forms 20, 21, and 22. The goal of this effort was to develop sufficient numbers of items to generate six ASVAB forms that will ultimately be content and statistically parallel to each other and to a reference form, ASVAB Form 8a. Three times as many experimental items as ultimately needed for the six forms were developed (N = 2,754) and administered to basic recruits at Lackland Air Force Base, Texas, from April 1988 to January 1989. The experimental and ASVAB Form 8a items were administered in a random groups design with approximately 500 examinees responding to experimental items and approximately 1,000 examinees responding to the ASVAB Form 8a items. Classical and item response theory item indices were calculated and items that did not meet certain statistical criteria were identified. Rejection of an item was recommended if (a) the item difficulty or (a) discrimination was below .3, (b) the correct option had a negative correlation with total test score, and (c) incorrect options had positive correlations with total test score. In addition, an examination of how well the experimental items matched the ASVAB Form 8a items was made. It was concluded that in general the				
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distributions of the experimental and Form 8a item statistics were similar and that the development of six new ASVAB forms parallel with one another and to ASVAB Form 8a could be accomplished in a later effort.

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**ARMED SERVICES VOCATIONAL APTITUDE BATTERY (ASVAB)
FORMS 20, 21, AND 22: ITEM DEVELOPMENT**

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SUMMARY

This paper documents the effort to develop items for the next generation of Armed Services Vocational Aptitude Battery (ASVAB) Forms 20, 21, and 22. The ASVAB is a multiple aptitude test battery that is used by each of the Armed Services to select enlisted personnel and to classify the personnel into occupations. New forms of the ASVAB are required to reduce test compromise and to update content. New forms must be content and statistically parallel to one another and to a reference form, Form 8a. Over 2,500 experimental items were written and administered along with the ASVAB Form 8a items. Experimental and Form 8a item statistics were calculated to determine if sufficient numbers of experimental items matched the Form 8a items. It was concluded that adequate numbers of experimental items matched the Form 8a items and that six new parallel forms of the ASVAB could be constructed in a subsequent effort.

PREFACE

This paper documents the efforts conducted in support of Prototype Development and Validation of Selection and Classification Instruments (Contract F41689-87-D-0012). This research and development (R & D) effort was conducted under the Development of the Armed Services Vocational Aptitude Battery Forms 20, 21, and 22 (Items and Item Bank) by Operational Technologies, Inc. (OPTECH), San Antonio, Texas.

We would like to express our sincere appreciation to Air Force Human Resources Laboratory scientists Dr. Malcolm James Ree, for his technical insights, and 2Lt Stephen D. Armstrong for his assistance in publishing the final copy. We also thank OPTECH personnel Juanita Nakasone and Laurie Shore for their data entry services. The contributions of these individuals were essential to this project.

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ARMED SERVICES VOCATIONAL APTITUDE BATTERY (ASVAB) FORMS 20, 21, AND 22: ITEM DEVELOPMENT

I. INTRODUCTION

The Armed Services Vocational Aptitude Battery (ASVAB) is the multiple aptitude battery used by all the armed services for selection and classification of enlisted personnel. The ASVAB consists of 10 multiple choice subtests, 8 power and 2 speeded. These 10 subtests, their content, the number of items, and time limits are shown in their order of administration in Table 1.

Four subtests are used to compute the Armed Forces Qualification Test (AFQT) score. This AFQT composite is calculated from the Arithmetic Reasoning (AR), Word Knowledge (WK), Paragraph Comprehension (PC), and Mathematics Knowledge (MK) standard scores and is used to determine the qualification of an applicant into any branch of the service. All the subtests are used in various Service-specific composites for determining an individual's training and job assignment.

Some versions of the ASVAB are administered in high schools for future recruiting and for counseling purposes. However, operational ASVAB versions are administered to applicants at military entrance processing stations (MEPS), mobile examining team (MET) sites, and Office of Personnel Management (OPM) sites.

The operational ASVAB versions periodically require the development of new test batteries to provide optimum test effectiveness in the allocation of enlisted resources and to deter test compromise. Effective job classification results in cost reductions due to higher productivity, higher reenlistment rates and reduced training school attrition.

The development of new operational ASVAB forms is accomplished in four major phases:

Phase I: Items are written, edited, checked for technical accuracy, and reviewed for population subgroup sensitivity. Booklets are developed and administered to Air Force recruits to obtain preliminary item statistics.

Phase II: Content and statistically suitable items are selected from Phase I. Overlength booklets are developed and booklets are administered to all-Service recruits to obtain item statistics based on a sample with a broader range of ability.

Phase III: Content and statistically suitable items are selected from Phase II. Operational length booklets are developed and trial equatings of the new operational tests with the reference test are performed.

Phase IV: Operational length booklets created in Phase III are administered to all-Service applicants to obtain item and subtest statistics based on a sample with a broader range of ability. Equatings of these operational booklets with the reference booklet are performed.

The focus of this paper is the Phase I stage of developing the new items for ASVAB Forms 20 to 22. This study encompasses three purposes:

1. the development of an adequate number of items to generate six ASVAB forms that will ultimately be content and statistically parallel to each other and to the reference ASVAB Form 8a and,
2. the configuring of experimental and 8a booklets for item testing, and
3. the administration of these booklets to obtain preliminary item statistics that will be used in a later effort to develop overlength forms.

Table 1. ASVAB Subtest Descriptions

Subtest ^a	Content	# Items	Time
General Science (GS)	Knowledge of or about physical, chemical, and biological properties	25	11
Arithmetic Reasoning (AR)	Reasoning required to perform arithmetic processes	20	36
Word Knowledge (WK)	The meanings of selected words	35	11
Paragraph Comprehension (PC)	Understanding of written material from brief paragraphs	15	13
Numerical Operations (NO) ^b	Knowledge of simple addition, subtraction, multiplication, and division	50	3
Coding Speed (CS) ^b	Ability to identify and match similar sets of numbers with words	84	7
Auto and Shop Information (AS)	Knowledge of and familiarity with tools and shop practices, and knowledge of and familiarity with maintenance, structure, and repair of automobiles	25	11
Mathematics Knowledge (MK)	Application of learned mathematic principles	25	24
Mechanical Comprehension (MC)	Understanding and application of various mechanical principles	25	19
Electronics Information (EI)	Identification or application of simple electrical or electronics knowledge	20	9

^a Subtests are presented in order of administration.
^b Speeded subtest

II. METHOD

Determination of the Number of Items within a Subtest

In determining the number of Phase I items to be generated, the convention exists that six unique parallel versions of the AFQT portion of the battery will be developed and three unique parallel versions of the non-AFQT portion of the battery will be developed. Thus, determining the number of items to be developed is contingent on the length of the subtest in operational format, whether it's an AFQT or non-AFQT subtest and the number of forms to be generated. Given these considerations, the number of items is then tripled to ensure sufficient numbers of items throughout Phase II and III analyses. The speeded subtest items were not generated in this study as they are typically produced during Phase II. The total number of items needed for Phase I of ASVAB Forms 20 to 22 are presented in Table 2.

Further, this effort was able to use power subtest items contained in previous operational booklets (see Appendix A). Approximately 20% of the total number of items for the item development stage of ASVAB Forms 20 to 22 were previously used items. Of these items, half were revised and regarded as new items and half were used verbatim.

Once the number of items for Phase I was determined, item writing for the experimental booklets began.

Table 2. Phase I Item Requirements^a

Subtest name	Number of forms	Number of items required per form ^b	Total number of items
<u>AFQT subtests</u>			
Word Knowledge (WK)	6	35 x 3	630
Paragraph Comprehension (PC)	6	15 x 3	270
Arithmetic Reasoning (AR)	6	30 x 3	540
Mathematics Knowledge (MK)	6	25 x 3	450
<u>Non-AFQT subtests</u>			
Electronics Information (EI)	3	20 x 3	180
Mechanical Comprehension	3	25 x 3	225
General Science (GS)	3	25 x 3	225
Auto and Shop Information (AS)	3	25 x 3	225
Total			2,745

^a Speeded subtests NO and CS are not developed in Phase I.

^b Three times (x 3) as many items as required for the operational length subtest were written.

Item Writing

With the total number of items that needed to be written determined, the following guidance was given to item writers. First, item writers were given a taxonomy for each subtest indicating the percentage of items that needed to be covered in particular content areas (see Appendix B). Given these percentages and the predetermined total number of items for each subtest, the number of items that needed to be written per content category were determined. The use of "all of the above" and "none of the above" as item alternatives was prohibited. Item content taken verbatim from copyrighted materials was not acceptable. Item writers could not use items present in current operational military tests or in books used for test preparation. For the PC subtest, at least 2 to 5 items needed to be written for each paragraph.

In addition to the new items, revised and unrevised previously used items were included in each subtest's item pool for a percentage not to exceed 20% for revised items and 20% for unrevised items. For many of the subtests there were not enough old items available for reuse in the development of forms to meet these percentages. This meant that over 60% of the item pool contained new items written in order to approximate the total number of items needed for each taxonomic category.

Booklet Configurations

After all power subtest items had been written according to the criteria, experimental forms and the reference Form 8a booklets were configured.

Experimental booklet configurations in Phase I were based on the number of items to be included in each overlength subtest which, in turn, was contingent on the total number of items needed for each subtest. Complete ASVAB booklets, in overlength format, were not constructed because the testing time was limited to 3 1/2 hours. Partial booklets consisting of a subset of ASVAB subtests were configured with equal numbers of items in the 8a and experimental subtests.

Certain experimental subtests were grouped together to form a partial booklet and were assigned an Air Force Human Resources Laboratory (AFHRL) booklet number (see Appendix C). ASVAB booklet MO88057 contained General Science (GS), Mechanical Comprehension (MC), Auto and Shop Information (AS), and Electronics Information (EI) 8a subtests. ASVAB booklets MO88058 through MO88063 contained GS, MC, AS, and EI experimental subtests. MO88064 contained GS, MC, AS but did not contain the EI subtest because fewer EI items were required. ASVAB booklet MO88065 contained Word Knowledge (WK), Paragraph Comprehension (PC), and Mathematics Knowledge (MK) 8a subtests while ASVAB booklets MO88066 through MO88078 contained WK, PC, and MK experimental subtests. Booklet MO88079 contained only WK items since fewer PC and MK items were required. For the remaining subtest, Arithmetic Reasoning (AR), no overlength booklets were made so that examinees would not become fatigued during the testing session. The AR subtests (MO88074, 8a; MO88095 through MO88112, experimental) were single-subtest booklets which resulted in the need for more testing sessions to administer the total number of items required.

Administration Plan

An administration plan and administration instructions were created. The goal of administration was to produce randomly equivalent groups for all booklets.

Phase I testing of experimental and 8a partial booklets was conducted at Lackland Air Force Base (AFB), Texas, between April 1988 and January 1989. The partial booklets were administered with their own answer forms according to the following plan with a typical session testing approximately 150 subjects:

- The experimental AR booklets containing 30 experimental items were randomly distributed with approximately every 8th person receiving the 8a AR booklet, also containing 30 items. This resulted in at least 540 subjects being administered each of the 14 AR experimental booklets and at least 1,080 subjects being administered the AR 8a items across all testing sessions.
- The experimental WK series, containing 44 WK items, 21 PC items and 34 MK items were randomly distributed with approximately every 6th person receiving the 8a counterpart. This resulted in at least 560 subjects being administered each WK series booklet and at least 1,120 subjects being administered the WK 8a series across all testing sessions.
- The experimental GS series, containing 31 GS items, 31 AS items, 31 MC items and 20 EI items were randomly distributed with approximately every 4th person receiving the GS 8a counterpart. This resulted in at least 525 subjects being administered each GS experimental booklet series and at least 1,050 subjects being administered the GS 8a series across all testing sessions.

If all three booklet series were administered, AR with a separate answer form was administered first. The AR booklets and answer forms were collected and the WK series with another answer form was distributed. The WK booklets and answer forms were collected and the GS series with another answer form was distributed. The GS booklets and answer forms were collected and the subjects dismissed. The total testing time for this type of session was approximately 2 3/4 hours.

If only 2 booklet series were administered, the above procedure was followed with the administration order being the AR booklet then the WK series, or the AR booklet then the GS series. The total testing time was about 1 3/4 hour.

Instructions for administering each series of partial booklets were developed to insure standard administration for all testing sessions. These instructions were extracted from the standard ASVAB administration manual (Department of Defense, 1983) and adapted to accommodate the partial booklet testing format.

Subjects

Item responses were collected from samples of approximately 500 to 800 for each experimental subtest and approximately 1,000 for each reference subtest. These samples consisted of male and female Air Force recruits undergoing basic military training at Lackland AFB, Texas. All subjects' answer forms were scanned, and for ease of subsequent data processing individual experimental and 8a booklet session files were built. Since fewer than 100 subjects were administered the 8a items in a given session, the 8a item responses were accumulated across testing sessions so that item statistics could be estimated using a large sample. The number of Air Force recruits present at each testing session is shown in Table 3.

Table 3. Total Number of Subjects Per Session

Session #	Booklet number	# of subjects
1	M088094 (AR-8a)	60
	M088095 (AR-X)	559
	M088065 (WK-8A)	80
	M08806 (WK-X)	539
2	M088094 (AR-8A)	65
	M088096 (AR-X)	592
	M088065 (WK-8A)	84
	M088067 (WK-X)	578
3	M088094 (AR-8A)	65
	M088097 (AR-X)	570
	M088065 (WK-8A)	82
	M088068 (WK-X)	556
4	M088094 (AR-8A)	65
	M088098 (AR-X)	586
	M088065 (WK-8A)	82
	M088069 (WK-X)	570
5	M088094 (AR-8A)	66
	M088099 (AR-X)	629
	M088057 (GS-8A)	179
	M088058 (GS-X)	525
6	M088094 (AR-8A)	62
	M088100 (AR-X)	558
	M088057 (GS-8A)	170
	M088059 (GS-X)	511
	M088065 (WK-8A)	85
	M088070 (WK-X)	599
7	M088094 (AR-8A)	61
	M088101 (AR-X)	570
	M088065 (WK-8A)	79
	M088071 (WK-X)	557
8	M088094 (AR-8A)	63
	M088102 (AR-X)	572
	M088065 (WK-8A)	79
	M088072 (WK-X)	555
9	M088094 (AR-8A)	65
	M088103 (AR-X)	584
	M088065 (WK-8A)	81
	M088073 (WK-X)	571
10	M088094 (AR-8A)	65
	M088104 (AR-X)	592
	M088065 (WK-8A)	81
	M088074 (WK-X)	572

Data Analysis

The first stage of data analysis was to analyze the items using both classical and item response theory (IRT) methods. For each item in a subtest, two classical item indices were computed. One index was p-value, which is an indication of how difficult the item is and is defined as the proportion of people answering the item correctly. The other was discrimination, which is the biserial correlation between item and test scores and is an indication of how well the item discriminates between low and high ability examinees.

Table 3. (Concluded)

11	M088094 (AR-8A)	78
	M088105 (AR-X)	708
	M088057 (GS-8A)	195
	M088060 (GS-X)	587
12	M088094 (AR-8A)	87
	M088106 (AR-X)	795
	M088065 (WK-8A)	109
	M088075 (WK-X)	772
13	M088094 (AR-8A)	71
	M088107 (AR-X)	638
	M088057 (GS-8A)	176
	M088061 (GS-X)	531
14	M088094 (AR-8A)	73
	M088108 (AR-X)	681
	M088057 (GS-8A)	189
	M088062 (GS-X)	562
15	M088094 (AR-8A)	69
	M088109 (AR-X)	629
	M088057 (GS-8A)	174
	M088063 (GS-X)	527
	M088065 (WK-8A)	89
	M088076 (WK-X)	612
16	M088094 (AR-8A)	69
	M088110 (AR-X)	625
	M088065 (WK-8A)	86
	M088077 (WK-X)	608
17	M088094 (AR-8A)	65
	M088111 (AR-X)	586
	M088065 (WK-8A)	81
	M088078 (WK-X)	568
18	M088094 (AR-8A)	72
	M088112 (AR-X)	664
	M088057 (GS-8A)	182
	M088064 (GS-X)	553
	M088065 (WK-8A)	91
	M088079 (WK-X)	648

Item response theory indices were estimated using ASCAL a MicroCAT testing system computer program that estimates parameters according to the three parameter logistic model (Office of Naval Research, 1985). (For the interested reader, a detailed description of item response theory models can be obtained in Lord, 1980.) Item indices that were estimated included discrimination (a parameter), an indication of how well the item discriminates between low and high ability examinees; difficulty (b parameter), an indication of the item difficulty; and pseudo-guessing (c parameter), the probability of answering the item correctly by chance.

For both the classical and item response theory analyses, the 8a items were analyzed both with and without the additional items (i.e., overlength format) so that test length effects on estimation were consistent. These analyses of the items from 8a only resulted in item statistics to be used in the matching and selection of experimental items.

The next stage of data analysis was to determine if items were within a

particular specified difficulty range. Appendix D presents the targeted distributions of difficulty value ranges for each of the power subtests. The distribution of both classical item statistics and the three item response theory parameter estimates were calculated. Examination of these distributions determined which items met minimum statistical requirements. Items were deemed unacceptable statistically if the difficulty or discrimination values were below .30. In addition, items with discrimination values that were negative and items with responses to a distractor that positively correlated with total scores were deemed unacceptable.

Examining the statistically acceptable experimental subtest items to see if a match could be made with corresponding 8a subtest items was performed to determine if there were sufficient numbers of experimental items to create six new forms of the ASVAB in a future effort. For example, the p-value and biserial correlation of each experimental GS was compared to the p-value and biserial correlation of each 8a GS item to determine which items matched. For the AFQT subtests, each 8a item must have at least 6 experimental item matches. For the non-AFQT subtests, each 8a item must have at least 3 experimental item matches.

After the matching process was accomplished, experimental items that were statistically acceptable and that could be matched with 8a items were recommended for use in Phase II development of overlength forms.

III. RESULTS AND DISCUSSION

The classical and IRT statistics are presented in Appendix E for the 2754 experimental and 200 Form 8a items. Examination of the distribution of experimental and 8a item statistics provided a means for identifying those experimental items that did not meet minimum statistical standards and provided a comparison of the experimental and 8a statistic distributions.

Generally, the p-values for all experimental and 8a subtests appear to be distributed as expected and approximate the target distributions (Appendix D). The experimental p-values range from .000 to 1.000 with a majority of the items possessing values between .301 and 1.000. The 8a difficulty values range from .301 to 1.000 with the greatest number of values to be matched above .500. Thus, the ability to match experimental item p-values with 8a item p-values was accomplished.

The biserial correlations (discrimination indices) were distributed as expected for the experimental and 8a subtest. As can be seen in Appendix E, the biserial correlations for the experimental items range from .000 to 1.000 with a majority of the values from .201 to .800. The exceptions to this were GS, MC, and EI where a significant number of items possessed lower biserial correlations. Appendix E also presents the number of items which possessed negative biserial correlations (table row labeled "negative"). These items with negative biserial correlations are not acceptable for further use. The 8a biserial correlations generally range from .301 to 1.000 with the exception of one item each from AS, MK, and EI with lower biserials. Most of the 8a biserial correlations were within the .301 and .700 range with the exception of 8 WK items, 2 PC items, 5 AS items, and 4 MK items which possess higher biserial correlations. Again, the potential matching of experimental biserial correlations with 8a biserial correlations was realized.

To visually examine in graphic form the simultaneous matching of

experimental item p-values and biserial correlations with 8a item p-values and biserial correlations, graphs were generated with discrimination on the x-axis and difficulty on the y-axis. Note that the graphs are not presented in this paper; however, an example is presented in Figure 1. Graphing the items in this manner provided a visual means of determining how many experimental items, per subtest, did not match an 8a item or fell below the .30 value for p-value or biserial correlation. Table 4 presents in tabular form the information contained in the graphs.

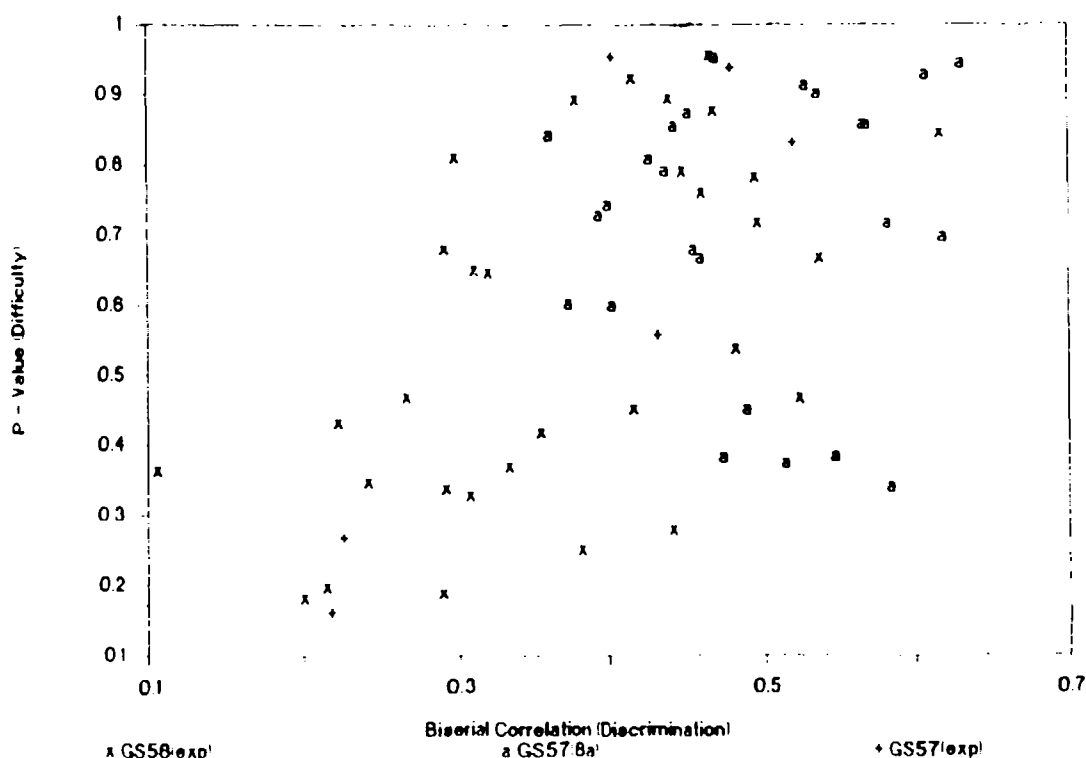


Figure 1. Difficulty by Discrimination for General Science: Form 8a Booklet M088057 Versus Experimental Booklet M088058.

In the simultaneous matching process, relaxed difference criteria were used. A +.20 point difference criterion for discrimination was chosen since biserial correlations have a relatively high sampling variance and a tendency to fluctuate when items are administered to small samples or samples that differ in ability. For difficulty, the difference criterion of +.10 was chosen. For samples that more closely approximate the target population, a more stringent criteria should be chosen. A summary for each subtest of the number of items that were statistically acceptable and that also matched 8a items follows (see also Table 5).

For the GS subtest 64 experimental items possessed a difficulty or discrimination value below .30. These 64 GS experimental items should not be considered in the development of overlength forms. The remaining 159 GS experimental items appear to statistically match the 8a GS production items within the tolerance limits.

Table 4. Frequency of Experimental and 8a Items Crosstabulated
By Difficulty and Discrimination^a

General Science								
Difficulty Range	Unaccept- able	.31- .40	.41- .50	Discrimination range .51- .60	.61- .70	.71- .80	.81- .90	.91- 1.00
Unacceptable	20	9	3	4	1	-	-	-
.31-.40	8	8	4 (1)	2 (3)	-	-	-	-
.41-.50	6	7	5 (1)	5	2	-	-	-
.51-.60	3	2	12	9	2	-	-	-
.61-.70	2	6 (1)	13 (3)	5	- (1)	-	-	-
.71-.80	3	7	14 (3)	6	1 (1)	-	-	-
.81-.90	3	5 (1)	8 (3)	9 (2)	2	1	-	-
.91-1.00	2	4	14 (1)	3 (2)	1 (2)	2	-	-
Arithmetic Reasoning								
Unacceptable	10	2	4	1	1	-	-	-
.31-.40	3	2	6 (1)	3 (1)	2	-	-	-
.41-.50	1	3	13 (1)	14 (1)	6 (2)	-	-	-
.51-.60	-	2	14	26 (2)	14 (2)	-	-	-
.61-.70	-	2	19 (1)	42 (4)	19	2	-	-
.71-.80	-	6	17	41 (4)	51 (2)	5	-	-
.81-.90	1	4 (1)	23 (2)	40 (1)	36 (3)	12	-	-
.91-1.00	2	8 (1)	18	21 (1)	30	9	4	1

Table 4. (Continued)

Word Knowledge								
Difficulty Range	Unaccept- able	Discrimination range						
		.31- .40	.41- .50	.51- .60	.61- .70	.71- .80	.81- .90	.91- 1.00
Unacceptable	37	13	7	1	2	-	-	-
.31-.40	15	8	8	3	3	-	-	-
.41-.50	8	11	10	13 (1)	4	-	-	-
.51-.60	6	13	15 (3)	14 (1)	10	-	-	-
.61-.70	2	7	23 (1)	24 (1)	3 (1)	1	-	-
.71-.80	6	7	16 (1)	23 (1)	19 (1)	1	-	-
.81-.90	7	10	19	22 (2)	20 (2)	4 (1)	-	-
.91-1.00	22	20 (1)	40	60 (5)	27 (6)	18 (3)	11 (1)	12 (3)
Paragraph Comprehension								
Unacceptable	12	-	1	-	-	-	-	-
.31-.40	2	1	2	-	-	-	-	-
.41-.50	1	-	1	2	-	-	-	-
.51-.60	-	4	5 (1)	7	-	-	-	-
.61-.70	2	6	13 (1)	9 (1)	-	-	-	-
.71-.80	1	3	17 (1)	18 (1)	8	1	-	-
.81-.90	2	6	17	33 (4)	12 (2)	5	2	1
.91-1.00	1	5	14	25 (1)	12 (1)	14 (1)	8	6 (1)

Table 4. (Continued)

Auto and Shop Information								
Difficulty Range	Unaccept- able	Discrimination range						
		.31- .40	.41- .50	.51- .60	.61- .70	.71- .80	.81- .90	.91- 1.00
Unacceptable	16	4	3	1	1	-	-	-
.31-.40	7	3	6 (1)	2	1	- (1)	-	-
.41-.50	2	3 (1)	3	5	4	1	-	-
.51-.60	5	7 (1)	6	5	9 (1)	5 (2)	-	-
.61-.70	1	7 (3)	6 (2)	5 (1)	9 (2)	4	-	-
.71-.80	-	3 (1)	11	10 (2)	12 (1)	4 (2)	-	-
.81-.90	2 (1)	1	9 (1)	11 (1)	4	2	-	-
.91-1.00	1	1	5 (1)	7	6	3	-	-
Mathematics Knowledge								
Unacceptable	13	6	11	4	6	1	-	-
.31-.40	3	4	12	10	8 (1)	5	-	-
.41-.50	3	8	11 (1)	16 (1)	12 (1)	5 (1)	-	-
.51-.60	2	8	16	30 (2)	20 (1)	7	1	-
.61-.70	-	3	15	34 (1)	23 (2)	7 (1)	1	-
.71-.80	-	5	17 (1)	28 (2)	17 (2)	12 (2)	3	-
.81-.90	- (1)	6	8	11 (1)	17 (2)	3	-	-
.91-1.00	-	6 (1)	2 (1)	5	4	2	-	-

Table 4. (Concluded)

Mechanical Comprehension								
Difficulty Range	Unaccept- able	Discrimination range						
		.31- .40	.41- .50	.51- .60	.61- .70	.71- .80	.81- .90	.91- 1.00
Unacceptable	26	8	4	1	-	-	-	-
.31-.40	14	8	3 (1)	1	-	-	-	-
.41-.50	5	5	10 (2)	2 (2)	1	-	-	-
.51-.60	5	5	11	9 (3)	1	-	-	-
.61-.70	2	5	8 (2)	9 (2)	5 (3)	-	-	-
.71-.80	-	7 (1)	5 (2)	8 (1)	3 (3)	2	-	-
.81-.90	-	7	6 (1)	15 (1)	9	2	-	-
.91-1.00	-	1	3 (1)	-	6	1	-	-
Electronics Information								
Unacceptable	15 (1)	2	8	2	3	-	-	-
.31-.40	7	5	4	3 (1)	1	-	-	-
.41-.50	5	9	7 (3)	6	1 (1)	-	-	-
.51-.60	4	8	10	6 (2)	2	-	-	-
.61-.70	2	1	13 (1)	4	2 (1)	-	-	-
.71-.80	4	6	7 (3)	6 (1)	3	-	-	-
.81-.90	-	4	9 (1)	10 (2)	3 (3)	-	-	-
.91-1.00	1	-	3	2	2	-	-	-

^a Unacceptable is defined as a value below .30 for difficulty and below .30 or negative for discrimination. Frequencies in parentheses refer to number of 8a items that fall within the cell; frequencies not in parentheses refer to the number of experimental items.

The AR subtests had 25 experimental items with p-values or biserials below the .30 criterion. In addition, 8 experimental items appeared not to match 8a items statistically. Therefore a minimum of 33 experimental items should be culled and not used in the development of overlength forms. Of all the subtests, AR had the lowest percentage (6%) of items that needed to be culled and had a total of 507 good items for future consideration.

Of the WK experimental items, 126 have p-values or biserials below .30 and should not be used in the next phase of test development. The remainder of the WK experimental booklet items ($N = 499$) statistically match 8a items and can be used in future form development.

Twenty-two PC experimental items possess p-values or biserials below .30 and 3 items do not statistically match an 8a item within the +.20 point difference. Therefore, 25 PC experimental booklet items should not be used in later development. The remaining 246 PC items meet statistical acceptability criteria and match 8a items.

For the AS experimental items, 43 items do not meet the .30 biserial criterion and 2 items do not statistically match an 8a item. In the development of overlength forms, a minimum of 45 AS experimental booklet items should not be used; however, a total of 178 AS items can be considered for future use.

The MK experimental items were found to have 49 items not meeting the .30 criterion. However, the remainder of the MK items appears to simultaneously match an 8a item's p-value and biserial correlation. Thus, 49 MK items should be culled leaving 402 MK items for consideration in the development of overlength forms.

Table 5. Number of Experimental Form 20 to 22 Items to be Considered in Overlength Development

	Min. # Items needed	# to be considered	# NGT to be used	% loss
GS	75	159	64	29%
AR	180	507	33	6%
WK	210	499	126	20%
PC	90	254	25	9%
AS	75	178	45	20%
MK	150	402	49	11%
MC	75	158	65	29%
EI	60	137	53	28%
TOTAL	915	2,294	460	

Among the MC experimental items, 65 did not meet the .30 biserial criterion. The remainder of the MC items ($N = 158$) did statistically match 8a items. A total of 65 MC experimental booklet items should not be used in the next test development stage.

Fifty-three EI experimental items had p-values or biserials below .30. However, the remainder of the EI items ($N = 137$) statistically match 8a items. Therefore, 53 EI experimental booklet items should not be considered in the development of overlength booklets.

The 8a and experimental items IRT a, b, and c parameters were comparable. The a's, or discrimination index, for both sets of items generally range from .301 to 2.500 with the greatest percentage of a's ranging from .501 to 1.400. The b's, or difficulty parameter, for both experimental and 8a items generally range from -3.000 to 3.000 which were the default lower and upper limits of the estimation program.

Great caution is required in interpreting b values of absolute high values (+ or - 2.5 or more) as most samples including the present one offer little statistical information in these regions. Large sampling errors exist in these ranges but they represent the best point estimate available. Intervals of .2 were created to compute the frequencies of the b's. Most of these intervals were represented by 1% to 4% of the items. Exceptions to this representation occurred within the experimental GS, AS, MC, and EI subtests in which the 2.901 to 3.000 range was represented by 9% of the items.

In summary, examination of both classical and item response theory statistical distributions indicated that sufficient numbers of experimental items were statistically acceptable and were statistically comparable to corresponding 8a items. Thus, the next stage of form development involving the construction of 6 overlength forms that are parallel to one another and to ASVAB Form 8a could be accomplished in a later effort.

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APPENDIX A: PREVIOUS ASVAB BOOKLETS USED IN THE DEVELOPMENT OF ASVAB FORMS 20 to 22

Table A-1. Previous ASVAB Booklets Used in the Development
of Form 20 to 22 Subtest Items

Booklet #	Subtests
1304.12b (ASVAB "1")	WK, AR, MC, AI, SI, EI
ASVAB 2	WK, AR, MC, AI, SI, EI
ASVAB 3	WK, AR, MC, AI, SI, EI
ASVAB 4	WK, AR, MC, AI, SI, EI
ASVAB 11a	GS, AR, WK, PC, AS, MK, MC, EI
ASVAB 11b	AR, WK, PC
ASVAB 12b	AR, WK, PC

APPENDIX B: ASVAB TAXONOMY

Table B-1. ASVAB Taxonomy

Subtest	Content domain	Item %
General Science (GS)	Life Science	45%
	Physical Science	45%
	Earth Science	
Arithmetic Reasoning (AR)	Rearrangement of Operations	35%
	Equivalent Fractions	35%
	Percentages	15%
	Arithmetic Operations	15%
Word Knowledge (WK)	"Most nearly means..." stem	60%
	Complete Sentence Stem	40%
	Nouns	35%
	Verbs	30%
	Adjectives	35%
Paragraph Comprehension (PC)	Literal Recall	40%
	Paraphrase	40%
	Inferences	20%
Auto and Shop Information (AS)	Engines	43%
	Body/Drive Train	43%
	Electronics	14%
	Tools	70%
	Materials	30%
Mathematics Knowledge (MK)	Common Fractions	25%
	Geometry	25%
	Exponents/Roots	15%
	Equation Solving	30%
	Factorials	5%
Mechanical Comprehension (MC)	Simple Machines	10%
	Compound Machines	40%
	Complex Compound Machines	20%
	Mechanical Concepts	30%
Electronics Information (EI)	Theory	20%
	Circuits	10%
	Power/Electricity	40%
	Tools/Regulators	30%

APPENDIX C: ASVAB FORMS 20 to 22 LACKLAND BOOKLET CONFIGURATIONS

Table C-1. ASVAB FORMS 20 to 22 Lackland Booklet Configurations

Lackland Booklet #	Subtests included
M088057	GS(8a), MC(8a), AS(8a), EI(8a)
M088058-M088063	GS, MC, AS, EI
M088064	GS, MC, AS
M088065	WK(8a), PC(8a), MK(8a)
M088066-M088078	WK, PC, MK
M088079	WK
M088094	AR(8a)
M088095-M088112	AR

APPENDIX D: TARGET ASVAB ITEM P-VALUES

Table D-1. Target P-values

Distribution of item difficulties in each operational length subtest								
Difficulty	WK	PC	AR	MK	EI	MC	GS	AS
.95-.90	3-4 ^a	1-2	2-3	1-2	1	1-2	1-2	1-2
.89-.80	6-7	3-4	5-6	3-4	3-4	3-4	3-4	3-4
.79-.70	6-7	4-5	5-6	4-5	4-5	4-5	4-5	4-5
.69-.60	6-7	4-5	5-6	4-5	4-5	4-5	4-5	4-5
.59-.50	6-7	4-5	5-6	4-5	4-5	4-5	4-5	4-5
.49-.40	5-6	2-3	3-4	4-5	4-5	4-5	4-5	4-5
.39-.35	1-2	1-2	1-2	1-2	1-2	1-2	1-2	1-2

^a 3-4 means that 3 to 4 items are to be within this difficulty range.

APPENDIX E: SUBTEST CLASSICAL AND IRT STATISTIC FREQUENCY INTERVALS

Table E-1. General Science Frequencies of Item Statistics for 223 Experimental and 25 Form 8a Items.

P-value					
Experimental Range	N	%	8A Range	N	%
.000 - .100	2	0.01	.000 - .100	0	0.00
.101 - .200	17	0.08	.101 - .200	0	0.00
.201 - .300	18	0.08	.201 - .300	0	0.00
.301 - .400	22	0.10	.301 - .400	4	0.16
.401 - .500	25	0.11	.401 - .500	1	0.04
.501 - .600	28	0.13	.501 - .600	0	0.00
.601 - .700	26	0.12	.601 - .700	5	0.20
.701 - .800	31	0.14	.701 - .800	4	0.16
.801 - .900	28	0.13	.801 - .900	6	0.24
.901 - 1.000	26	0.12	.901 - 1.000	5	0.20
Biserial Correlation					
Experimental Range	N	%	8A Range	N	%
Negative	2	0.01	Negative	0	0.00
.000 - .100	3	0.01	.000 - .100	0	0.00
.101 - .200	13	0.06	.101 - .200	0	0.00
.201 - .300	29	0.13	.201 - .300	0	0.00
.301 - .400	48	0.22	.301 - .400	2	0.08
.401 - .500	73	0.33	.401 - .500	12	0.48
.501 - .600	43	0.19	.501 - .600	7	0.28
.601 - .700	9	0.04	.601 - .700	4	0.16
.701 - .800	3	0.01	.701 - .800	0	0.00
.801 - .900	0	0.00	.801 - .900	0	0.00
.901 - 1.000	0	0.00	.901 - 1.000	0	0.00

Table E-1. (Continued)

IRT Discrimination (a) Parameter					
Experimental Range	N	%	8A Range	N	%
Negative	0	0.00	Negative	0	0.00
.000	0	0.00	.000	0	0.00
.001 - .100	0	0.00	.001 - .100	0	0.00
.101 - .200	0	0.00	.101 - .200	0	0.00
.201 - .300	0	0.00	.201 - .300	0	0.00
.301 - .400	5	0.02	.301 - .400	0	0.00
.401 - .500	8	0.04	.401 - .500	6	0.24
.501 - .600	30	0.13	.501 - .600	1	0.04
.601 - .700	26	0.12	.601 - .700	5	0.20
.701 - .800	21	0.09	.701 - .800	0	0.00
.801 - .900	18	0.08	.801 - .900	2	0.08
.901 - 1.000	18	0.08	.901 - 1.000	2	0.08
1.001 - 1.100	11	0.05	1.001 - 1.100	0	0.00
1.101 - 1.200	8	0.04	1.101 - 1.200	1	0.04
1.201 - 1.300	8	0.04	1.201 - 1.300	1	0.04
1.301 - 1.400	11	0.05	1.301 - 1.400	2	0.08
1.401 - 1.500	9	0.04	1.401 - 1.500	0	0.00
1.501 - 1.600	7	0.03	1.501 - 1.600	0	0.00
1.601 - 1.700	10	0.04	1.601 - 1.700	0	0.00
1.701 - 1.800	7	0.03	1.701 - 1.800	0	0.00
1.801 - 1.900	4	0.02	1.801 - 1.900	0	0.00
1.901 - 2.000	5	0.02	1.901 - 2.000	1	0.04
2.001 - 2.100	2	0.01	2.001 - 2.100	1	0.04
2.101 - 2.200	4	0.02	2.101 - 2.200	0	0.00
2.201 - 2.300	4	0.02	2.201 - 2.300	2	0.08
2.301 - 2.400	3	0.01	2.301 - 2.400	1	0.04
2.401 - 2.500	4	0.02	2.401 - 2.500	0	0.00

Table E-1. (Concluded)

IRT Difficulty (b) Parameter					
Experimental Range	N	%	SA Range	N	%
-3.000 - -2.801	7	0.03	-3.000 - -2.801	0	0.00
-2.800 - -2.601	2	0.01	-2.800 - -2.601	1	0.04
-2.600 - -2.401	1	0.00	-2.600 - -2.401	0	0.00
-2.400 - -2.201	5	0.02	-2.400 - -2.301	0	0.00
-2.200 - -2.001	5	0.02	-2.200 - -2.001	0	0.00
-2.000 - -1.801	9	0.04	-2.000 - -1.801	3	0.12
-1.800 - -1.601	7	0.03	-1.800 - -1.601	4	0.16
-1.600 - -1.401	7	0.03	-1.600 - -1.401	2	0.08
-1.400 - -1.201	4	0.02	-1.400 - -1.201	0	0.00
-1.200 - -1.001	10	0.04	-1.200 - -1.001	0	0.00
-1.000 - -.801	7	0.03	-1.000 - -.801	3	0.12
-.800 - -.601	11	0.05	-.800 - -.601	0	0.00
-.600 - -.401	10	0.04	-.600 - -.401	1	0.04
-.400 - -.201	7	0.03	-.400 - -.201	2	0.08
-.200 - .000	10	0.04	-.200 - .000	0	0.00
.001 - .200	11	0.05	.001 - .200	2	0.08
.201 - .400	10	0.04	.201 - .400	0	0.00
.401 - .600	11	0.05	.401 - .600	1	0.04
.601 - .800	8	0.04	.601 - .800	1	0.04
.801 - 1.000	4	0.02	.801 - 1.000	3	0.12
1.001 - 1.200	3	0.01	1.001 - 1.200	1	0.04
1.201 - 1.400	6	0.03	1.201 - 1.400	1	0.04
1.401 - 1.600	7	0.03	1.401 - 1.600	0	0.00
1.601 - 1.800	9	0.04	1.601 - 1.800	0	0.00
1.801 - 2.000	6	0.03	1.801 - 2.000	0	0.00
2.001 - 2.200	6	0.03	2.001 - 2.200	0	0.00
2.201 - 2.400	6	0.03	2.201 - 2.400	0	0.00
2.401 - 2.600	10	0.04	2.401 - 2.600	0	0.00
2.601 - 2.800	2	0.01	2.601 - 2.800	0	0.00
2.801 - 3.000	22	0.10	2.801 - 3.000	0	0.00
IRT Pseudo-Guessing (c) Parameter					
Experimental Range	N	%	SA Range	N	%
Inestimable	1	0.00	Inestimable	0	0.00
.000 - .100	10	0.04	.000 - .100	0	0.00
.101 - .200	39	0.17	.101 - .200	5	0.20
.201 - .300	111	0.50	.201 - .300	12	0.48
.301 - .400	52	0.23	.301 - .400	8	0.32
.401 - .500	10	0.04	.401 - .500	0	0.00

Table E-2. Arithmetic Reasoning Frequencies of Item Statistics for 540 Experimental and 30 Form 8a Items

P-value					
Experimental Range	N	%	8A Range	N	%
.000 - .100	7	0.01	.000 - .100	0	0.00
.101 - .200	3	0.01	.101 - .200	0	0.00
.201 - .300	8	0.01	.201 - .300	0	0.00
.301 - .400	16	0.03	.301 - .400	2	0.07
.401 - .500	37	0.07	.401 - .500	4	0.13
.501 - .600	56	0.10	.501 - .600	4	0.13
.601 - .700	84	0.16	.601 - .700	5	0.17
.701 - .800	120	0.22	.701 - .800	6	0.20
.801 - .900	116	0.21	.801 - .900	7	0.23
.901 - 1.000	93	0.17	.901 - 1.000	2	0.07
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Biserial Correlation					
Experimental Range	N	%	8A Range	N	%
Negative	10	0.02	Negative	0	0.00
.000 - .100	0	0.00	.000 - .100	0	0.00
.101 - .200	4	0.01	.101 - .200	0	0.00
.201 - .300	3	0.01	.201 - .300	0	0.00
.301 - .400	29	0.05	.301 - .400	2	0.07
.401 - .500	114	0.21	.401 - .500	5	0.17
.501 - .600	188	0.35	.501 - .600	14	0.47
.601 - .700	159	0.29	.601 - .700	9	0.30
.701 - .800	28	0.05	.701 - .800	0	0.00
.801 - .900	4	0.01	.801 - .900	0	0.00
.901 - 1.000	1	0.00	.901 - 1.000	0	0.00
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Table E-2. (Continued)

IRT Discrimination (a) Parameter					
Experimental Range	N	%	8A Range	N	%
Negative	0	0.00	Negative	0	0.00
.000	0	0.00	.000	0	0.00
.001 - .100	0	0.00	.001 - .100	0	0.00
.101 - .200	0	0.00	.101 - .200	0	0.00
.201 - .300	0	0.00	.201 - .300	0	0.00
.301 - .400	0	0.00	.301 - .400	0	0.00
.401 - .500	21	0.04	.401 - .500	1	0.03
.501 - .600	39	0.07	.501 - .600	2	0.07
.601 - .700	52	0.10	.601 - .700	3	0.10
.701 - .800	65	0.12	.701 - .800	2	0.07
.801 - .900	65	0.12	.801 - .900	4	0.13
.901 - 1.000	54	0.10	.901 - 1.000	6	0.20
1.001 - 1.100	50	0.09	1.001 - 1.100	1	0.03
1.101 - 1.200	26	0.05	1.101 - 1.200	2	0.07
1.201 - 1.300	18	0.03	1.201 - 1.300	4	0.13
1.301 - 1.400	20	0.04	1.301 - 1.400	3	0.10
1.401 - 1.500	26	0.05	1.401 - 1.500	0	0.00
1.501 - 1.600	12	0.02	1.501 - 1.600	0	0.00
1.601 - 1.700	12	0.02	1.601 - 1.700	0	0.00
1.701 - 1.800	11	0.02	1.701 - 1.800	0	0.00
1.801 - 1.900	12	0.02	1.801 - 1.900	2	0.07
1.901 - 2.000	14	0.03	1.901 - 2.000	0	0.00
2.001 - 2.100	10	0.02	2.001 - 2.100	0	0.00
2.101 - 2.200	15	0.03	2.101 - 2.200	0	0.00
2.201 - 2.300	10	0.02	2.201 - 2.300	0	0.00
2.301 - 2.400	4	0.01	2.301 - 2.400	0	0.00
2.401 - 2.500	4	0.01	2.401 - 2.500	0	0.00

Table E-2. (Concluded)

IRT Difficulty (b) Parameter					
Experimental Range	N	%	SA Range	N	%
-3.000 - -2.801	25	0.05	-3.000 - -2.801	1	0.03
-2.800 - -2.601	17	0.03	-2.800 - -2.601	0	0.00
-2.600 - -2.401	17	0.03	-2.600 - -2.401	1	0.00
-2.400 - -2.201	18	0.03	-2.400 - -2.301	0	0.00
-2.200 - -2.001	14	0.03	-2.200 - -2.001	0	0.00
-2.000 - -1.801	24	0.04	-2.000 - -1.801	2	0.07
-1.800 - -1.601	20	0.04	-1.800 - -1.601	1	0.03
-1.600 - -1.401	30	0.06	-1.600 - -1.401	3	0.10
-1.400 - -1.201	25	0.05	-1.400 - -1.201	1	0.03
-1.200 - -1.001	40	0.07	-1.200 - -1.001	1	0.03
-1.000 - -.801	27	0.05	-1.000 - -.801	2	0.07
-.800 - -.601	36	0.07	-.800 - -.601	1	0.03
-.600 - -.401	38	0.07	-.600 - -.401	0	0.00
-.400 - -.201	34	0.06	-.400 - -.201	3	0.10
-.200 - .000	28	0.05	-.200 - .000	2	0.07
.001 - .200	22	0.04	.001 - .200	3	0.10
.201 - .400	24	0.04	.201 - .400	4	0.13
.401 - .600	25	0.05	.401 - .600	1	0.03
.601 - .800	16	0.03	.601 - .800	1	0.03
.801 - 1.000	18	0.03	.801 - 1.000	1	0.03
1.001 - 1.200	12	0.02	1.001 - 1.200	1	0.03
1.201 - 1.400	6	0.01	1.201 - 1.400	1	0.03
1.401 - 1.600	4	0.01	1.401 - 1.600	0	0.00
1.601 - 1.800	3	0.01	1.601 - 1.800	0	0.00
1.801 - 2.000	2	0.00	1.801 - 2.000	0	0.00
2.001 - 2.200	0	0.00	2.001 - 2.200	0	0.00
2.201 - 2.400	0	0.00	2.201 - 2.400	0	0.00
2.401 - 2.600	2	0.00	2.401 - 2.600	0	0.00
2.601 - 2.800	0	0.00	2.601 - 2.800	0	0.00
2.801 - 3.000	13	0.02	2.801 - 3.000	0	0.00
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IRT Pseudo-Guessing (c) Parameter					
Experimental Range	N	%	SA Range	N	%
Inestimable	0	0.00	Inestimable	0	0.00
.000 - .100	14	0.03	.000 - .100	0	0.00
.101 - .200	81	0.15	.101 - .200	10	0.33
.201 - .300	321	0.59	.201 - .300	15	0.50
.301 - .400	100	0.19	.301 - .400	5	0.17
.401 - .500	24	0.04	.401 - .500	0	0.00
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Table E-3. Word Knowledge Frequencies of Item Statistics for
625 Experimental and 35 Form 8a Items

P-value					
Experimental Range	N	%	8A Range	N	%
.000 - .100	4	0.01	.000 - .100	0	0.00
.101 - .200	19	0.03	.101 - .200	0	0.00
.201 - .300	37	0.06	.201 - .300	0	0.00
.301 - .400	37	0.06	.301 - .400	0	0.00
.401 - .500	46	0.07	.401 - .500	1	0.03
.501 - .600	58	0.09	.501 - .600	4	0.11
.601 - .700	60	0.10	.601 - .700	3	0.09
.701 - .800	72	0.12	.701 - .800	3	0.09
.801 - .900	82	0.13	.801 - .900	5	0.14
.901 - 1.000	210	0.34	.901 - 1.000	19	0.54
Biserial Correlation					
Experimental Range	N	%	8A Range	N	%
Negative	9	0.01	Negative	0	0.00
.000 - .100	10	0.02	.000 - .100	0	0.00
.101 - .200	23	0.04	.101 - .200	0	0.00
.201 - .300	60	0.10	.201 - .300	0	0.00
.301 - .400	89	0.14	.301 - .400	1	0.03
.401 - .500	138	0.22	.401 - .500	5	0.14
.501 - .600	160	0.26	.501 - .600	11	0.31
.601 - .700	88	0.14	.601 - .700	10	0.29
.701 - .800	24	0.04	.701 - .800	4	0.11
.801 - .900	11	0.02	.801 - .900	1	0.03
.901 - 1.000	12	0.02	.901 - 1.000	3	0.09

Table E-3. (Continued)

IRT Discrimination (a) Parameter					
Experimental Range	N	%	8A Range	N	%
Negative	0	0.00	Negative	0	0.00
.000	0	0.00	.000	0	0.00
.001 - .100	1	0.00	.001 - .100	0	0.00
.101 - .200	0	0.00	.101 - .200	0	0.00
.201 - .300	0	0.00	.201 - .300	0	0.00
.301 - .400	18	0.03	.301 - .400	1	0.03
.401 - .500	35	0.06	.401 - .500	1	0.03
.501 - .600	40	0.06	.501 - .600	2	0.06
.601 - .700	57	0.09	.601 - .700	8	0.23
.701 - .800	65	0.10	.701 - .800	2	0.06
.801 - .900	56	0.09	.801 - .900	4	0.11
.901 - 1.000	54	0.09	.901 - 1.000	6	0.17
1.001 - 1.100	46	0.07	1.001 - 1.100	3	0.09
1.101 - 1.200	37	0.06	1.101 - 1.200	1	0.03
1.201 - 1.300	36	0.06	1.201 - 1.300	1	0.03
1.301 - 1.400	27	0.04	1.301 - 1.400	1	0.03
1.401 - 1.500	19	0.03	1.401 - 1.500	0	0.00
1.501 - 1.600	17	0.03	1.501 - 1.600	0	0.00
1.601 - 1.700	24	0.04	1.601 - 1.700	0	0.00
1.701 - 1.800	18	0.03	1.701 - 1.800	0	0.00
1.801 - 1.900	17	0.03	1.801 - 1.900	0	0.00
1.901 - 2.000	21	0.03	1.901 - 2.000	0	0.00
2.001 - 2.100	11	0.02	2.001 - 2.100	0	0.00
2.101 - 2.200	7	0.01	2.101 - 2.200	0	0.00
2.201 - 2.300	6	0.01	2.201 - 2.300	1	0.03
2.301 - 2.400	8	0.01	2.301 - 2.400	0	0.00
2.401 - 2.500	5	0.01	2.401 - 2.500	4	0.11

Table E-3. (Concluded)

IRT Difficulty (b) Parameter					
Experimental Range	N	%	SA Range	N	%
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-3.000 - -2.801	79	0.13	-3.000 - -2.801	11	0.31
-2.800 - -2.601	29	0.05	-2.800 - -2.601	3	0.09
-2.600 - -2.401	25	0.04	-2.600 - -2.401	2	0.06
-2.400 - -2.201	27	0.04	-2.400 - -2.301	0	0.00
-2.200 - -2.001	28	0.04	-2.200 - -2.001	0	0.00
-2.000 - -1.801	18	0.03	-2.000 - -1.801	2	0.06
-1.800 - -1.601	25	0.04	-1.800 - -1.601	2	0.06
-1.600 - -1.401	22	0.04	-1.600 - -1.401	0	0.00
-1.400 - -1.201	21	0.03	-1.400 - -1.201	2	0.06
-1.200 - -1.001	19	0.03	-1.200 - -1.001	2	0.06
-1.000 - -.801	17	0.03	-1.000 - -.801	1	0.03
-.800 - -.601	22	0.04	-.800 - -.601	1	0.03
-.600 - -.401	23	0.04	-.600 - -.401	0	0.00
-.400 - -.201	22	0.04	-.400 - -.201	0	0.00
-.200 - .000	23	0.04	-.200 - .000	3	0.09
.001 - .200	24	0.04	.001 - .200	1	0.03
.201 - .400	19	0.03	.201 - .400	0	0.00
.401 - .600	18	0.03	.401 - .600	2	0.06
.601 - .800	19	0.03	.601 - .800	0	0.00
.801 - 1.000	15	0.02	.801 - 1.000	3	0.09
1.001 - 1.200	13	0.02	1.001 - 1.200	0	0.00
1.201 - 1.400	17	0.03	1.201 - 1.400	0	0.00
1.401 - 1.600	10	0.02	1.401 - 1.600	0	0.00
1.601 - 1.800	12	0.02	1.601 - 1.800	0	0.00
1.801 - 2.000	11	0.02	1.801 - 2.000	0	0.00
2.001 - 2.200	12	0.02	2.001 - 2.200	0	0.00
2.201 - 2.400	11	0.02	2.201 - 2.400	0	0.00
2.401 - 2.600	9	0.01	2.401 - 2.600	0	0.00
2.601 - 2.800	5	0.01	2.601 - 2.800	0	0.00
2.801 - 3.000	30	0.05	2.801 - 3.000	0	0.00
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IRT Pseudo-Guessing (c) Parameter					
Experimental Range	N	%	SA Range	N	%
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Inestimable	2	0.00	Inestimable	0	0.00
.000 - .100	13	0.02	.000 - .100	0	0.00
.101 - .200	68	0.11	.101 - .200	1	0.03
.201 - .300	392	0.63	.201 - .300	16	0.46
.301 - .400	124	0.20	.301 - .400	15	0.43
.401 - .500	26	0.04	.401 - .500	3	0.09
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Table E-4. Paragraph Comprehension Frequencies of Item Statistics for 279 Experimental and 15 Form 8a Items

P-value					
Experimental Range	N	%	8A Range	N	%
.000 - .100	11	0.04	.000 - .100	0	0.00
.101 - .200	0	0.00	.101 - .200	0	0.00
.201 - .300	2	0.01	.201 - .300	0	0.00
.301 - .400	5	0.02	.301 - .400	0	0.00
.401 - .500	4	0.01	.401 - .500	0	0.00
.501 - .600	16	0.06	.501 - .600	1	0.07
.601 - .700	30	0.11	.601 - .700	2	0.13
.701 - .800	48	0.17	.701 - .800	2	0.13
.801 - .900	78	0.28	.801 - .900	6	0.40
.901 - 1.000	85	0.30	.901 - 1.000	4	0.27
Biserial Correlation					
Experimental Range	N	%	8A Range	N	%
Negative	6	0.02	Negative	0	0.00
.000 - .100	3	0.01	.000 - .100	0	0.00
.101 - .200	4	0.01	.101 - .200	0	0.00
.201 - .300	8	0.03	.201 - .300	0	0.00
.301 - .400	25	0.09	.301 - .400	0	0.00
.401 - .500	70	0.25	.401 - .500	3	0.20
.501 - .600	94	0.34	.501 - .600	7	0.47
.601 - .700	32	0.11	.601 - .700	3	0.20
.701 - .800	20	0.07	.701 - .800	1	0.07
.801 - .900	10	0.04	.801 - .900	0	0.00
.901 - 1.000	7	0.03	.901 - 1.000	1	0.07

Table E-4. (Continued)

IRT Discrimination (a) Parameter					
Experimental Range	N	%	8A Range	N	%
Negative	0	0.00	Negative	0	0.00
.000	0	0.00	.000	0	0.00
.001 - .100	0	0.00	.001 - .100	0	0.00
.101 - .200	0	0.00	.101 - .200	0	0.00
.201 - .300	0	0.00	.201 - .300	0	0.00
.301 - .400	14	0.05	.301 - .400	0	0.00
.401 - .500	37	0.13	.401 - .500	3	0.20
.501 - .600	37	0.13	.501 - .600	1	0.07
.601 - .700	41	0.15	.601 - .700	3	0.20
.701 - .800	18	0.06	.701 - .800	0	0.00
.801 - .900	12	0.04	.801 - .900	1	0.07
.901 - 1.000	12	0.04	.901 - 1.000	1	0.07
1.001 - 1.100	8	0.03	1.001 - 1.100	1	0.07
1.101 - 1.200	2	0.01	1.101 - 1.200	0	0.00
1.201 - 1.300	10	0.04	1.201 - 1.300	0	0.00
1.301 - 1.400	2	0.01	1.301 - 1.400	0	0.00
1.401 - 1.500	5	0.02	1.401 - 1.500	0	0.00
1.501 - 1.600	6	0.02	1.501 - 1.600	1	0.07
1.601 - 1.700	3	0.01	1.601 - 1.700	0	0.00
1.701 - 1.800	3	0.01	1.701 - 1.800	0	0.00
1.801 - 1.900	5	0.02	1.801 - 1.900	0	0.00
1.901 - 2.000	7	0.03	1.901 - 2.000	0	0.00
2.001 - 2.100	5	0.02	2.001 - 2.100	0	0.00
2.101 - 2.200	5	0.02	2.101 - 2.200	0	0.00
2.201 - 2.300	11	0.04	2.201 - 2.300	0	0.00
2.301 - 2.400	18	0.06	2.301 - 2.400	0	0.00
2.401 - 2.500	18	0.06	2.401 - 2.500	4	0.27

Table E-4. (Concluded)

IRT Difficulty (b) Parameter					
Experimental Range	N	%	SA Range	N	%
-3.000 - -2.801	34	0.12	-3.000 - -2.801	1	0.07
-2.800 - -2.601	12	0.04	-2.800 - -2.601	0	0.00
-2.600 - -2.401	12	0.04	-2.600 - -2.401	0	0.00
-2.400 - -2.201	15	0.05	-2.400 - -2.301	0	0.00
-2.200 - -2.001	16	0.06	-2.200 - -2.001	3	0.20
-2.000 - -1.801	16	0.06	-2.000 - -1.801	2	0.13
-1.800 - -1.601	18	0.06	-1.800 - -1.601	1	0.07
-1.600 - -1.401	19	0.07	-1.600 - -1.401	0	0.07
-1.400 - -1.201	6	0.02	-1.400 - -1.201	2	0.13
-1.200 - -1.001	14	0.05	-1.200 - -1.001	2	0.13
-1.000 - -.801	15	0.05	-1.000 - -.801	0	0.00
-.800 - -.601	11	0.04	-.800 - -.601	0	0.00
-.600 - -.401	9	0.03	-.600 - -.401	0	0.00
-.400 - -.201	7	0.03	-.400 - -.201	0	0.00
-.200 - .000	10	0.04	-.200 - .000	1	0.07
.001 - .200	8	0.03	.001 - .200	1	0.07
.201 - .400	7	0.03	.201 - .400	0	0.00
.401 - .600	4	0.01	.401 - .600	1	0.07
.601 - .800	12	0.04	.601 - .800	0	0.00
.801 - 1.000	7	0.03	.801 - 1.000	0	0.00
1.001 - 1.200	2	0.01	1.001 - 1.200	1	0.07
1.201 - 1.400	2	0.01	1.201 - 1.400	0	0.03
1.401 - 1.600	3	0.01	1.401 - 1.600	0	0.00
1.601 - 1.800	3	0.01	1.601 - 1.800	0	0.00
1.801 - 2.000	1	0.00	1.801 - 2.000	0	0.00
2.001 - 2.200	0	0.00	2.001 - 2.200	0	0.00
2.201 - 2.400	0	0.00	2.201 - 2.400	0	0.00
2.401 - 2.600	1	0.00	2.401 - 2.600	0	0.00
2.601 - 2.800	2	0.01	2.601 - 2.800	0	0.00
2.801 - 3.000	13	0.05	2.801 - 3.000	0	0.00
IRT Pseudo-Guessing (c) Parameter					
Experimental Range	N	%	SA Range	N	%
Inestimable	1	0.00	Inestimable	0	0.00
.000 - .100	18	0.06	.000 - .100	1	0.07
.101 - .200	17	0.06	.101 - .200	0	0.00
.201 - .300	155	0.56	.201 - .300	8	0.53
.301 - .400	57	0.20	.301 - .400	3	0.20
.401 - .500	31	0.11	.401 - .500	3	0.20

Table E-5. Auto and Shop Information Frequencies of Item Statistics for 223 Experimental and 25 Form 8a Items

P-value					
Experimental Range	N	%	8A Range	N	%
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.000 - .100	7	0.03	.000 - .100	0	0.00
.101 - .200	8	0.04	.101 - .200	0	0.00
.201 - .300	10	0.04	.201 - .300	0	0.00
.301 - .400	19	0.09	.301 - .400	2	0.08
.401 - .500	18	0.08	.401 - .500	1	0.04
.501 - .600	37	0.17	.501 - .600	4	0.16
.601 - .700	33	0.15	.601 - .700	8	0.32
.701 - .800	42	0.19	.701 - .800	6	0.24
.801 - .900	26	0.12	.801 - .900	3	0.12
.901 - 1.000	23	0.10	.901 - 1.000	1	0.04
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Biserial Correlation					
Experimental Range	N	%	8A Range	N	%
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Negative	10	0.04	Negative	0	0.00
.000 - .100	4	0.02	.000 - .100	0	0.00
.101 - .200	8	0.04	.101 - .200	0	0.00
.201 - .300	15	0.07	.201 - .300	1	0.04
.301 - .400	23	0.10	.301 - .400	6	0.24
.401 - .500	53	0.24	.401 - .500	5	0.20
.501 - .600	44	0.20	.501 - .600	4	0.16
.601 - .700	46	0.21	.601 - .700	4	0.16
.701 - .800	20	0.09	.701 - .800	5	0.20
.801 - .900	0	0.00	.801 - .900	0	0.00
.901 - 1.000	0	0.00	.901 - 1.000	0	0.00
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Table E-5. (Continued)

IRT Discrimination (a) Parameter					
Experimental Range	N	%	SA Range	N	%
Negative	0	0.00	Negative	0	0.00
.000	0	0.00	.000	0	0.00
.001 - .100	0	0.00	.001 - .100	0	0.00
.101 - .200	0	0.00	.101 - .200	0	0.00
.201 - .300	0	0.00	.201 - .300	0	0.00
.301 - .400	4	0.02	.301 - .400	2	0.08
.401 - .500	8	0.04	.401 - .500	4	0.16
.501 - .600	18	0.08	.501 - .600	1	0.04
.601 - .700	23	0.10	.601 - .700	3	0.12
.701 - .800	9	0.04	.701 - .800	5	0.20
.801 - .900	15	0.07	.801 - .900	0	0.00
.901 - 1.000	19	0.09	.901 - 1.000	0	0.00
1.001 - 1.100	13	0.06	1.001 - 1.100	1	0.04
1.101 - 1.200	14	0.06	1.101 - 1.200	1	0.04
1.201 - 1.300	8	0.04	1.201 - 1.300	0	0.00
1.301 - 1.400	13	0.06	1.301 - 1.400	1	0.04
1.401 - 1.500	12	0.05	1.401 - 1.500	0	0.00
1.501 - 1.600	10	0.04	1.501 - 1.600	1	0.04
1.601 - 1.700	10	0.04	1.601 - 1.700	0	0.00
1.701 - 1.800	9	0.04	1.701 - 1.800	1	0.04
1.801 - 1.900	10	0.04	1.801 - 1.900	0	0.00
1.901 - 2.000	8	0.04	1.901 - 2.000	0	0.00
2.001 - 2.100	5	0.02	2.001 - 2.100	1	0.04
2.101 - 2.200	4	0.02	2.101 - 2.200	0	0.00
2.201 - 2.300	6	0.03	2.201 - 2.300	1	0.04
2.301 - 2.400	3	0.01	2.301 - 2.400	2	0.08
2.401 - 2.500	2	0.01	2.401 - 2.500	1	0.04

Table E-5. (Concluded)

IRT Difficulty (b) Parameter					
Experimental Range	N	%	8A Range	N	%
-3.000 - -2.801	5	0.02	-3.000 - -2.801	0	0.00
-2.800 - -2.601	2	0.01	-2.800 - -2.601	0	0.00
-2.600 - -2.401	2	0.01	-2.600 - -2.401	0	0.00
-2.400 - -2.201	3	0.01	-2.400 - -2.301	0	0.00
-2.200 - -2.001	6	0.03	-2.200 - -2.001	1	0.04
-2.000 - -1.801	7	0.03	-2.000 - -1.801	2	0.08
-1.800 - -1.601	4	0.02	-1.800 - -1.601	0	0.00
-1.600 - -1.401	6	0.03	-1.600 - -1.401	0	0.00
-1.400 - -1.201	10	0.04	-1.400 - -1.201	3	0.12
-1.200 - -1.001	8	0.04	-1.200 - -1.001	1	0.04
-1.000 - -.801	8	0.04	-1.000 - -.801	0	0.00
-.800 - -.601	19	0.09	-.800 - -.601	4	0.16
-.600 - -.401	10	0.04	-.600 - -.401	1	0.04
-.400 - -.201	10	0.04	-.400 - -.201	3	0.12
-.200 - .000	14	0.06	-.200 - .000	2	0.08
.001 - .200	13	0.06	.001 - .200	2	0.08
.201 - .400	11	0.05	.201 - .400	0	0.00
.401 - .600	11	0.05	.401 - .600	2	0.08
.601 - .800	7	0.03	.601 - .800	1	0.04
.801 - 1.000	10	0.04	.801 - 1.000	1	0.04
1.001 - 1.200	8	0.04	1.001 - 1.200	0	0.00
1.201 - 1.400	5	0.02	1.201 - 1.400	1	0.04
1.401 - 1.600	7	0.03	1.401 - 1.600	1	0.04
1.601 - 1.800	2	0.01	1.601 - 1.800	0	0.00
1.801 - 2.000	4	0.02	1.801 - 2.000	0	0.00
2.001 - 2.200	3	0.01	2.001 - 2.200	0	0.00
2.201 - 2.400	3	0.01	2.201 - 2.400	0	0.00
2.401 - 2.600	1	0.00	2.401 - 2.600	0	0.00
2.601 - 2.800	2	0.01	2.601 - 2.800	0	0.00
2.801 - 3.000	22	0.00	2.801 - 3.000	0	0.00
IRT Pseudo-Guessing (c) Parameter					
Experimental Range	N	%	8A Range	N	%
Inestimable	0	0.00	Inestimable	0	0.00
.000 - .100	14	0.06	.000 - .100	3	0.12
.101 - .200	56	0.25	.101 - .200	8	0.32
.201 - .300	96	0.43	.201 - .300	9	0.36
.301 - .400	43	0.19	.301 - .400	4	0.16
.401 - .500	14	0.06	.401 - .500	1	0.04

Table E-6. Mathematics Knowledge Frequencies of Item Statistics for 451 Experimental and 25 Form 8a Items

P-value					
Experimental Range	N	%	8A Range	N	%
.000 - .100	2	0.00	.000 - .100	0	0.00
.101 - .200	14	0.03	.101 - .200	0	0.00
.201 - .300	25	0.06	.201 - .300	0	0.00
.301 - .400	42	0.09	.301 - .400	1	0.04
.401 - .500	55	0.12	.401 - .500	4	0.16
.501 - .600	84	0.19	.501 - .600	3	0.12
.601 - .700	83	0.18	.601 - .700	4	0.16
.701 - .800	82	0.18	.701 - .800	7	0.28
.801 - .900	45	0.10	.801 - .900	4	0.16
.901 - 1.000	19	0.04	.901 - 1.000	2	0.08
Biserial Correlation					
Experimental Range	N	%	8A Range	N	%
Negative	6	0.01	Negative	0	0.00
.000 - .100	5	0.01	.000 - .100	0	0.00
.101 - .200	5	0.01	.101 - .200	1	0.04
.201 - .300	5	0.01	.201 - .300	0	0.00
.301 - .400	46	0.10	.301 - .400	1	0.04
.401 - .500	92	0.20	.401 - .500	3	0.12
.501 - .600	138	0.31	.501 - .600	7	0.28
.601 - .700	107	0.24	.601 - .700	9	0.36
.701 - .800	42	0.09	.701 - .800	4	0.16
.801 - .900	5	0.01	.801 - .900	0	0.00
.901 - 1.000	0	0.00	.901 - 1.000	0	0.00

Table E-6. (Continued)

IRT Discrimination (a) Parameter					
Experimental Range	N	%	8A Range	N	%
Negative	0	0.00	Negative	0	0.00
.000	0	0.00	.000	0	0.00
.001 - .100	0	0.00	.001 - .100	0	0.00
.101 - .200	0	0.00	.101 - .200	0	0.00
.201 - .300	0	0.00	.201 - .300	0	0.00
.301 - .400	0	0.00	.301 - .400	1	0.04
.401 - .500	16	0.04	.401 - .500	1	0.04
.501 - .600	26	0.06	.501 - .600	1	0.04
.601 - .700	30	0.07	.601 - .700	1	0.04
.701 - .800	35	0.08	.701 - .800	4	0.16
.801 - .900	42	0.09	.801 - .900	3	0.12
.901 - 1.000	46	0.10	.901 - 1.000	2	0.08
1.001 - 1.100	29	0.06	1.001 - 1.100	4	0.16
1.101 - 1.200	33	0.07	1.101 - 1.200	1	0.04
1.201 - 1.300	33	0.07	1.201 - 1.300	0	0.00
1.301 - 1.400	26	0.06	1.301 - 1.400	1	0.04
1.401 - 1.500	23	0.05	1.401 - 1.500	0	0.00
1.501 - 1.600	18	0.04	1.501 - 1.600	1	0.04
1.601 - 1.700	20	0.04	1.601 - 1.700	1	0.04
1.701 - 1.800	19	0.04	1.701 - 1.800	0	0.00
1.801 - 1.900	16	0.04	1.801 - 1.900	0	0.00
1.901 - 2.000	11	0.02	1.901 - 2.000	2	0.08
2.001 - 2.100	12	0.03	2.001 - 2.100	0	0.00
2.101 - 2.200	10	0.02	2.101 - 2.200	0	0.00
2.201 - 2.300	0	0.00	2.201 - 2.300	2	0.08
2.301 - 2.400	2	0.00	2.301 - 2.400	0	0.00
2.401 - 2.500	4	0.01	2.401 - 2.500	0	0.00

Table E-6. (Concluded)

IRT Difficulty (b) Parameter					
Experimental Range	N	%	8A Range	N	%
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-3.000 - -2.801	1	0.00	-3.000 - -2.801	2	0.08
-2.800 - -2.601	4	0.01	-2.800 - -2.601	1	0.04
-2.600 - -2.401	1	0.00	-2.600 - -2.401	0	0.00
-2.400 - -2.201	2	0.00	-2.400 - -2.301	0	0.00
-2.200 - -2.001	5	0.01	-2.200 - -2.001	0	0.00
-2.000 - -1.801	5	0.01	-2.000 - -1.801	0	0.00
-1.800 - -1.601	5	0.01	-1.800 - -1.601	0	0.00
-1.600 - -1.401	10	0.02	-1.600 - -1.401	1	0.04
-1.400 - -1.201	21	0.05	-1.400 - -1.201	0	0.00
-1.200 - -1.001	21	0.05	-1.200 - -1.001	4	0.16
-1.000 - -.801	15	0.03	-1.000 - -.801	2	0.08
-.800 - -.601	33	0.07	-.800 - -.601	1	0.04
-.600 - -.401	33	0.07	-.600 - -.401	5	0.20
-.400 - -.201	32	0.07	-.400 - -.201	0	0.00
-.200 - .000	27	0.06	-.200 - .000	0	0.00
.001 - .200	34	0.08	.001 - .200	1	0.04
.201 - .400	32	0.07	.201 - .400	1	0.04
.401 - .600	34	0.08	.401 - .600	3	0.12
.601 - .800	28	0.06	.601 - .800	2	0.08
.801 - 1.000	18	0.04	.801 - 1.000	1	0.04
1.001 - 1.200	17	0.04	1.001 - 1.200	1	0.04
1.201 - 1.400	19	0.04	1.201 - 1.400	0	0.00
1.401 - 1.600	16	0.04	1.401 - 1.600	0	0.00
1.601 - 1.800	4	0.01	1.601 - 1.800	0	0.00
1.801 - 2.000	5	0.01	1.801 - 2.000	0	0.00
2.001 - 2.200	7	0.02	2.001 - 2.200	0	0.00
2.201 - 2.400	2	0.00	2.201 - 2.400	0	0.00
2.401 - 2.600	4	0.01	2.401 - 2.600	0	0.00
2.601 - 2.800	0	0.00	2.601 - 2.800	0	0.00
2.801 - 3.000	16	0.04	2.801 - 3.000	0	0.00
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IRT Pseudo-Guessing (c) Parameter					
Experimental Range	N	%	8A Range	N	%
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Inestimable	0	0.00	Inestimable	0	0.00
.000 - .100	32	0.07	.000 - .100	3	0.12
.101 - .200	155	0.34	.101 - .200	11	0.44
.201 - .300	191	0.42	.201 - .300	9	0.36
.301 - .400	64	0.14	.301 - .400	2	0.08
.401 - .500	9	0.02	.401 - .500	0	0.00
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Table E-7. Mechanical Comprehension Frequencies of Item Statistics for 223 Experimental and 25 Form 8a Items

P-value					
Experimental Range	N	%	8A Range	N	%
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.000 - .100	3	0.01	.000 - .100	0	0.00
.101 - .200	14	0.06	.101 - .200	0	0.00
.201 - .300	22	0.10	.201 - .300	0	0.00
.301 - .400	26	0.12	.301 - .400	1	0.04
.401 - .500	23	0.10	.401 - .500	4	0.16
.501 - .600	31	0.14	.501 - .600	3	0.12
.601 - .700	29	0.13	.601 - .700	7	0.28
.701 - .800	25	0.11	.701 - .800	7	0.28
.801 - .900	39	0.17	.801 - .900	2	0.08
.901 - 1.000	11	0.05	.901 - 1.000	1	0.04
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Biserial Correlation					
Experimental Range	N	%	8A Range	N	%
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Negative	4	0.02	Negative	0	0.00
.000 - .100	5	0.02	.000 - .100	0	0.00
.101 - .200	11	0.05	.101 - .200	0	0.00
.201 - .300	32	0.14	.201 - .300	0	0.00
.301 - .400	46	0.21	.301 - .400	1	0.04
.401 - .500	50	0.22	.401 - .500	9	0.36
.501 - .600	45	0.20	.501 - .600	9	0.36
.601 - .700	25	0.11	.601 - .700	6	0.24
.701 - .800	5	0.02	.701 - .800	0	0.00
.801 - .900	0	0.00	.801 - .900	0	0.00
.901 - 1.000	0	0.00	.901 - 1.000	0	0.00
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Table E-7. (Continued)

IRT Discrimination (a) Parameter					
Experimental Range	N	%	8A Range	N	%
Negative	0	0.00	Negative	0	0.00
.000	0	0.00	.000	0	0.00
.001 - .100	0	0.00	.001 - .100	0	0.00
.101 - .200	0	0.00	.101 - .200	0	0.00
.201 - .300	0	0.00	.201 - .300	0	0.00
.301 - .400	6	0.03	.301 - .400	1	0.04
.401 - .500	12	0.05	.401 - .500	2	0.08
.501 - .600	18	0.08	.501 - .600	3	0.12
.601 - .700	19	0.09	.601 - .700	3	0.12
.701 - .800	20	0.09	.701 - .800	4	0.16
.801 - .900	13	0.06	.801 - .900	0	0.00
.901 - 1.000	11	0.05	.901 - 1.000	3	0.12
1.001 - 1.100	19	0.09	1.001 - 1.100	2	0.08
1.101 - 1.200	11	0.05	1.101 - 1.200	2	0.08
1.201 - 1.300	9	0.04	1.201 - 1.300	3	0.12
1.301 - 1.400	12	0.05	1.301 - 1.400	1	0.04
1.401 - 1.500	10	0.04	1.401 - 1.500	0	0.00
1.501 - 1.600	15	0.07	1.501 - 1.600	0	0.00
1.601 - 1.700	10	0.04	1.601 - 1.700	0	0.00
1.701 - 1.800	7	0.03	1.701 - 1.800	0	0.00
1.801 - 1.900	11	0.05	1.801 - 1.900	0	0.00
1.901 - 2.000	7	0.03	1.901 - 2.000	0	0.00
2.001 - 2.100	2	0.01	2.001 - 2.100	0	0.00
2.101 - 2.200	2	0.01	2.101 - 2.200	0	0.00
2.201 - 2.300	3	0.01	2.201 - 2.300	1	0.04
2.301 - 2.400	1	0.00	2.301 - 2.400	0	0.00
2.401 - 2.500	5	0.02	2.401 - 2.500	0	0.00

Table E-7. (Concluded)

IRT Difficulty (b) Parameter					
Experimental Range	N	%	SA Range	N	%
-3.000 - -2.801	2	0.01	-3.000 - -2.801	0	0.00
-2.800 - -2.601	1	0.00	-2.800 - -2.601	1	0.04
-2.600 - -2.401	1	0.00	-2.600 - -2.401	0	0.00
-2.400 - -2.201	5	0.02	-2.400 - -2.301	1	0.04
-2.200 - -2.001	4	0.02	-2.200 - -2.001	0	0.00
-2.000 - -1.801	5	0.02	-2.000 - -1.801	0	0.00
-1.800 - -1.601	5	0.02	-1.800 - -1.601	1	0.04
-1.600 - -1.401	12	0.05	-1.600 - -1.401	1	0.04
-1.400 - -1.201	7	0.03	-1.400 - -1.201	0	0.00
-1.200 - -1.001	8	0.04	-1.200 - -1.001	1	0.04
-1.000 - -.801	5	0.02	-1.000 - -.801	2	0.08
-.800 - -.601	11	0.05	-.800 - -.601	2	0.08
-.600 - -.401	7	0.03	-.600 - -.401	1	0.04
-.400 - -.201	12	0.05	-.400 - -.201	5	0.20
-.200 - .000	15	0.07	-.200 - .000	2	0.08
.001 - .200	8	0.04	.001 - .200	0	0.00
.201 - .400	11	0.05	.201 - .400	2	0.08
.401 - .600	5	0.02	.401 - .600	1	0.04
.601 - .800	3	0.01	.601 - .800	1	0.04
.801 - 1.000	11	0.05	.801 - 1.000	1	0.04
1.001 - 1.200	7	0.03	1.001 - 1.200	3	0.12
1.201 - 1.400	10	0.04	1.201 - 1.400	0	0.00
1.401 - 1.600	7	0.03	1.401 - 1.600	0	0.00
1.601 - 1.800	8	0.04	1.601 - 1.800	0	0.00
1.801 - 2.000	4	0.02	1.801 - 2.000	0	0.00
2.001 - 2.200	8	0.04	2.001 - 2.200	0	0.00
2.201 - 2.400	5	0.02	2.201 - 2.400	0	0.00
2.401 - 2.600	7	0.03	2.401 - 2.600	0	0.00
2.601 - 2.800	6	0.03	2.601 - 2.800	0	0.00
2.801 - 3.000	23	0.10	2.801 - 3.000	0	0.00
IRT Pseudo-Guessing (c) Parameter					
Experimental Range	N	%	SA Range	N	%
Inestimable	0	0.00	Inestimable	0	0.00
.000 - .100	11	0.05	.000 - .100	2	0.08
.101 - .200	50	0.22	.101 - .200	7	0.28
.201 - .300	104	0.47	.201 - .300	14	0.56
.301 - .400	45	0.20	.301 - .400	2	0.08
.401 - .500	13	0.06	.401 - .500	0	0.00

Table E-8. Electronics Information Frequencies of Item Statistics for 190 Experimental and 20 Form 8a Items

P-value					
Experimental Range	N	%	8A Range	N	%
.000 - .100	1	0.01	.000 - .100	0	0.00
.101 - .200	10	0.05	.101 - .200	0	0.00
.201 - .300	19	0.10	.201 - .300	1	0.05
.301 - .400	20	0.11	.301 - .400	1	0.05
.401 - .500	28	0.15	.401 - .500	4	0.20
.501 - .600	30	0.16	.501 - .600	2	0.10
.601 - .700	22	0.12	.601 - .700	2	0.10
.701 - .800	26	0.14	.701 - .800	4	0.20
.801 - .900	26	0.14	.801 - .900	6	0.30
.901 - 1.000	8	0.04	.901 - 1.000	0	0.00
Biserial Correlation					
Experimental Range	N	%	8A Range	N	%
Negative	1	0.01	Negative	0	0.00
.000 - .100	8	0.04	.000 - .100	0	0.00
.101 - .200	9	0.05	.101 - .200	0	0.00
.201 - .300	20	0.11	.201 - .300	1	0.05
.301 - .400	35	0.18	.301 - .400	0	0.00
.401 - .500	61	0.32	.401 - .500	8	0.40
.501 - .600	39	0.21	.501 - .600	6	0.30
.601 - .700	17	0.09	.601 - .700	5	0.25
.701 - .800	0	0.00	.701 - .800	0	0.00
.801 - .900	0	0.00	.801 - .900	0	0.00
.901 - 1.000	0	0.00	.901 - 1.000	0	0.00

Table E-8. (Continued)

IRT Discrimination (a) Parameter					
Experimental Range	N	%	8A Range	N	%
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Negative	0	0.00	Negative	0	0.00
.000	0	0.00	.000	0	0.00
.001 - .100	0	0.00	.001 - .100	0	0.00
.101 - .200	0	0.00	.101 - .200	0	0.00
.201 - .300	0	0.00	.201 - .300	0	0.00
.301 - .400	11	0.06	.301 - .400	0	0.00
.401 - .500	15	0.08	.401 - .500	3	0.15
.501 - .600	12	0.06	.501 - .600	4	0.20
.601 - .700	20	0.11	.601 - .700	0	0.00
.701 - .800	19	0.10	.701 - .800	1	0.05
.801 - .900	13	0.07	.801 - .900	4	0.20
.901 - 1.000	9	0.05	.901 - 1.000	0	0.00
1.001 - 1.100	8	0.04	1.001 - 1.100	0	0.00
1.101 - 1.200	9	0.05	1.101 - 1.200	0	0.00
1.201 - 1.300	10	0.05	1.201 - 1.300	0	0.00
1.301 - 1.400	4	0.02	1.301 - 1.400	1	0.05
1.401 - 1.500	6	0.03	1.401 - 1.500	0	0.00
1.501 - 1.600	5	0.03	1.501 - 1.600	1	0.05
1.601 - 1.700	9	0.05	1.601 - 1.700	0	0.00
1.701 - 1.800	11	0.06	1.701 - 1.800	0	0.00
1.801 - 1.900	6	0.03	1.801 - 1.900	0	0.00
1.901 - 2.000	4	0.02	1.901 - 2.000	0	0.00
2.001 - 2.100	0	0.00	2.001 - 2.100	0	0.00
2.101 - 2.200	4	0.02	2.101 - 2.200	0	0.00
2.201 - 2.300	4	0.02	2.201 - 2.300	2	0.10
2.301 - 2.400	5	0.03	2.301 - 2.400	2	0.10
2.401 - 2.500	6	0.03	2.401 - 2.500	2	0.10
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Table E-8. (Concluded)

IRT Difficulty (b) Parameter					
Experimental Range	N	%	8A Range	N	%
-3.000 - -2.801	1	0.01	-3.000 - -2.801	0	0.03
-2.800 - -2.601	0	0.01	-2.800 - -2.601	0	0.00
-2.600 - -2.401	2	0.01	-2.600 - -2.401	0	0.00
-2.400 - -2.201	3	0.02	-2.400 - -2.301	0	0.00
-2.200 - -2.001	1	0.01	-2.200 - -2.001	0	0.00
-2.000 - -1.801	4	0.02	-2.000 - -1.801	1	0.05
-1.800 - -1.601	3	0.02	-1.800 - -1.601	0	0.00
-1.600 - -1.401	8	0.04	-1.600 - -1.401	0	0.00
-1.400 - -1.201	6	0.03	-1.400 - -1.201	4	0.20
-1.200 - -1.001	12	0.06	-1.200 - -1.001	1	0.05
-1.000 - -.801	10	0.05	-1.000 - -.801	2	0.10
-.800 - -.601	6	0.03	-.800 - -.601	1	0.05
-.600 - -.401	7	0.04	-.600 - -.401	0	0.00
-.400 - -.201	4	0.02	-.400 - -.201	1	0.05
-.200 - .000	11	0.06	-.200 - .000	1	0.05
.001 - .200	4	0.02	.001 - .200	1	0.05
.201 - .400	7	0.04	.201 - .400	0	0.00
.401 - .600	12	0.06	.401 - .600	1	0.05
.601 - .800	9	0.05	.601 - .800	1	0.05
.801 - 1.000	7	0.04	.801 - 1.000	2	0.10
1.001 - 1.200	5	0.03	1.001 - 1.200	2	0.10
1.201 - 1.400	7	0.04	1.201 - 1.400	0	0.00
1.401 - 1.600	14	0.07	1.401 - 1.600	1	0.05
1.601 - 1.800	9	0.05	1.601 - 1.800	0	0.00
1.801 - 2.000	2	0.01	1.801 - 2.000	0	0.00
2.001 - 2.200	5	0.03	2.001 - 2.200	0	0.00
2.201 - 2.400	6	0.03	2.201 - 2.400	1	0.05
2.401 - 2.600	4	0.02	2.401 - 2.600	0	0.00
2.601 - 2.800	1	0.01	2.601 - 2.800	0	0.00
2.801 - 3.000	20	0.11	2.801 - 3.000	0	0.00
IRT Pseudo-Guessing (c) Parameter					
Experimental Range	N	%	8A Range	N	%
Inestimable	0	0.00	Inestimable	0	0.00
.000 - .100	11	0.06	.000 - .100	2	0.10
.101 - .200	40	0.21	.101 - .200	0	0.00
.201 - .300	84	0.44	.201 - .300	12	0.60
.301 - .400	43	0.23	.301 - .400	6	0.30
.401 - .500	12	0.06	.401 - .500	0	0.00